www.roavs.com EISSN: 2223-0343

RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Research article

Nutritive value and feeding of rice gluten meal in broiler chickens

A Metwally and M. Farahat

Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Zagazig University, Egypt

Article history
Received: 6 Dec, 2015
Revised: 15 Dec, 2015
Accepted: 16 Dec, 2015

Abstract

This experiment was aimed to determine the chemical composition of the rice gluten meal (RGM) and the effect of its feeding on the growth performance, some blood parameters, nutrient digestibility and carcass characteristics of broiler chickens as an alternative to corn gluten meal and soybean meal. Ross 308 one-day old broiler chicks (n = 300) were randomly divided into six experimental groups, receiving diets containing rice gluten meal with six different inclusion levels (0, 2.5, 5.0, 7.5, 10 and 12.5%) for 42 days. The experimental diets were formulated from maize, soybean meal, corn gluten meal and/or rice gluten meal and vegetable oil. All diets were isoenergetic and isonitrogenous. Titanium dioxide (TiO_2) was incorporated in the finisher period into each diet at a rate of 5 g/kg as an indigestible marker to enable assessment of nutrient digestibility (dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF) and starch). Growth performance parameters like body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were monitored weekly. At 42 days of age, blood samples were collected and serum was separated for determination of serum lipid profile, glucose, total protein, albumin and globulin. Five birds from each treatment were slaughtered on day 42, for measuring the carcass dressing percentage, and internal organ weights. Results showed that birds fed rice gluten meal with different inclusion rates up to 12.5% have had the same performance parameters like the control diet and there was no significant difference between the different treatments in BW, BWG, FI and FCR. Serum lipid profile, glucose, total protein, albumin and globulin of the different treatment were within the normal range and did not affected by increasing the level of rice gluten meal up to 12.5%. There were no differences in the dressing percentage and internal organs among treatments. Digestibility of DM, CP, EE, NDF and starch were similar across different treatments without any significant differences. In conclusion, birds fed the rice gluten diets compared well with those fed the control for growth performance, carcass dressing and nutrient digestibility and can be included in the broiler diet up to 12.5% without any adverse effect.

Keywords: rice gluten meal; broiler; performance; blood; digestibility; carcass

To cite this article: Metwally A and M Farahat, 2015. Nutritive value and feeding of rice gluten meal in broiler chickens. Res. Opin. Anim. Vet. Sci., 5(11): 443-451.

Introduction

Although broiler production in Egypt was rapidly increased over the last decade, satisfying their nutritional requirements is becoming a difficult task. This is primarily due to scarcity and high cost of feed and feed ingredients. For example, the amount of corn available for animal and poultry feed has been

***Corresponding author:** A Metwally, Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Zagazig University, Egypt; E-mail: drabdalla75@yahoo.com

decreased in the last years due to increased use of corn for ethanol production. (Kreutzer, 2012). As well, meeting the protein needs of broilers represents a very substantial part of the cost of feeding. Corn and corn by-product serve as a major energy source for most livestock diets, especially, non-ruminants like poultry. For example, corn and corn gluten accounts for approximately 55% (Mourao et al., 2008) and 6% (Seyedi and Hosseinkhani, 2014) of the feed, respectively. A decrease in the availability of corn, corn by-products and an increase in the price for feed have a direct impact on the broiler industry worldwide (Ayuk, 2004), and in some cases, production output is reduced (Donohue and Cunningham, 2009). Due to increased price of grains, poultry meat, and eggs, the ability of some of the world's population to purchase and consume chicken meat was decreased (Aho, 2007). In order to compensate for this change, alternative feed ingredients must be identified (Agwunobi, 1999). Therefore, researchers are exploring alternative feed sources to substitute for corn, corn by-product and soybean in poultry ration. Several studies have evaluated the use of possible alternative feed ingredients; however, more extensive feed trials must be done in order to meet the requirements set forth by the National Research Council (1994). It is not known what levels of inclusion of these alternative ingredients will produce the same quality product that is now produced by the broiler industry. Also, limited information is available on their impact on the meat quality. Therefore, much work must be done in evaluating these alternative ingredients. New ingredients should have the capacity to partially or completely substitute plant proteins like corn gluten and soybean, and at the same time not have a negative impact on the efficiency of broilers; i.e., it must not reduce feed efficiency or dressing percentage, and must produce a product of the same or superior quality (Ojewola et al., 2006).

One possible alternative is rice and rice by-products as a rice gluten meal. Rice and rice by-products have become a feed option to replace corn and corn by-products in the feed industry (Honda et al., 2011; Sittiya et al., 2011). Replacing corn with feed rice has been demonstrated to have no side effects for poultry, especially on feed intake, growth performance, and feed conversion (Alias and Ariffin. 2008; Asyifah et al., 2012). Rice gluten meal is the dried residue after removal of starch by the process employed in the wet milling manufacture of rice starch or syrup or glucose. Sherazi et al. (1995) reported that the rice gluten meal is rich in crude protein (47.3%) and has metabolizable energy as compared to fish meal. Although, the high nutritive value of the rice gluten meal, the feeding trials on its feeding to poultry are scarce. Based on feed cost, rice gluten meal could be an effective alternative feed ingredient in the diet of broilers. If diets can be formulated using this ingredient, farmers will be able to pay less for their feed, hence reducing their overhead cost. However, more work needs to be done to determine the optimum inclusion level of rice gluten meal in broiler diets. The objectives of this study were to evaluate the nutritive value of the rice gluten meal and to investigate the growth performance, some blood parameters, carcass traits, and nutrient digestibility of broiler chicks fed diets containing different levels of rice gluten meal as a substitute for corn gluten meal and soybean meal.

Materials and Methods

Chemical composition and nutritive value of rice gluten meal

Proximate chemical analysis of the rice gluten meal was done for crude protein, ether extract, ash and crude fiber according to AOAC (2006). Amino acid analysis was determined using ion exchange chromatography and amino acid analyzer according to European Commission (1998). The obtained results are reported in Tables 1a and 1b.

Experimental animals and brooding

This experiment was carried out at the Animal Experimental Station, Faculty of Veterinary Medicine, Zagazig University, Egypt. All experimental procedures follow the guidelines of the local experimental animal care committee. The experiment was carried out using 30 pens (replicate) with 10 chicks in each pen, giving 5 replicate pens per dietary treatment. Pens were equipped with feeders and drinkers. Feed and water were supplied *ad libitum* consumption. The chicks were reared in an environmentally controlled room. For the first three days, the birds were provided with a temperature of 33ºC and then reduced by 1°C every other day until a temperature of 25°C was reached, subsequently maintaining this temperature for the rest of the trial. After the first weak, 18 hours of lighting per day was provided throughout the trial.

The experimental diets

Three hundred and fifty one-day old ROSS chicks were purchased and incubated together in the first three days then the chicks were allocated to six experimental groups containing rice gluten meal (Tiba Starch and Glucose Manufacturing Company, New salheya, Egypt) with six different inclusion levels (0, 2.5, 5.0, 7.5, 10 and 12.5%). Each treatment had five replicates consisting of ten birds per replicate. The birds were reared from day 1 to day 42. Each feeding phase (starter, grower or finisher) was extended for two weeks. The experimental diets for starter (Table 2), grower (Table 3) and finisher (Table 4) were formulated mainly from maize, soybean meal, corn gluten meal and/or rice gluten meal and vegetable oil. The experimental diets for each phase were isoenergetic and isonitrogenous and were formulated to meet Ross 308 manual recommendations. Titanium dioxide (TiO_2) was incorporated in the finisher period into each diet at a rate of 5 g/kg as an indigestible marker to enable assessment of nutrients digestibility (dry matter, protein starch, fat and NDF).

Measurement

Mortality was recorded as it occurred, while body weight and feed consumption were measured per replicate at the start, in weekly intervals, and at the end of the experiment. The following growth performance parameters were determined: average weight gain per replicate, average feed intake per replicate, and feed conversion ratio measured as grams of feed per gram of weight gain after correcting for mortality.

As TiO_2 was incorporated in the finisher period, at the end of the experiment, one animal per replicate was chosen and kept individually for another seven days for determination of nutrients digestibility. During the final seven days of the experiment (morning and afternoon), clean excreta (free from feathers and feed) were collected. The excreta samples for each replicate from the seven days were pooled and then frozen for storage. Prior to analysis, the samples were dried in a forced air oven at 55°C for 72 h, followed by fine grinding. The TiO_2 concentration of the excreta and diet samples was measured according to the method of Short et al. (1999). Diets and excreta were analysed for dry matter, crude protein, ether extract, starch and NDF. The digestibility coefficients for dry matter, crude protein, fat, starch as well as NDF were determined using the equations for the indicator method described by Schneider and Flatt (1975).

Coefficients for apparent total tract digestibility (ATTD) were calculated based on the following equation:

$$\text{Total tract digestibility (\%)} = 100 - \frac{\text{(\%) indicator in feed}}{\text{(\%) indicator in feces}} \times \frac{\text{(\%) nutrient in feces}}{\text{(\%) nutrient in feed}} \times 100$$

At end of the experiment, individual blood samples were collected from the jugular vein (one sample from each replicate) and serum was separated. Serum lipid profile, glucose, total protein, albumin and globulin were determined using commercial kits.

Five birds per treatment (i.e. one bird per pen, representing the average body weight of pen) were used for determination of dressing percentage, calculated as follows: (slaughter weight × 100)/live weight. Slaughter weight was determined from the eviscerated and dressed carcasses in which the head, neck, feet and lower wing were removed. As well, internal organs (heart, gizzard, spleen and liver) were determined as a percentage of carcass dressing.

Statistical analysis

The model was as follows:

$$Y_{ij} = \mu + treatment_i + e_{ij}$$

Where, Yij = observation value of the dependant variable, μ = overall mean, treatmenti = fixed effect of treatment, eij = residual error.

Pen was the experimental unit in the production study for the responses feed consumption, body weight, body weight gain and feed conversion ratio, whereas for dressing percentage, blood sample and in the digestibility experiment, the individual bird was the experimental unit. One-way ANOVA (PROC GLM) was performed using the ANOVA procedure of SAS (SAS Institute, 2001). Results are presented as means for each diet, and variance is expressed as the residual SD (RSD; root MSE in SAS) of the model. Significant differences among diets were assessed for statistical significance by F-Test (diet vs. eij) ($P< 0.05$).

Results and Discussion

Chemical composition and nutritive value of rice gluten meal

Rice gluten meal is the dried reside after removal of starch by the process employed in the wet milling of rice starch, syrup or glucose. Proximate and amino acid compositions of rice gluten meal were tabulated in Tables 1a and 1b. Results indicated that rice gluten meal have a good nutritive value that attributed to its high crude protein content (57.6%) and good amino acid composition (Table 1b). Moreover, rice gluten meal has a lower level of crude fiber (1.45%) and moderate level of ether extract (3.16%). These values are in agreement with the data described before by Sherazi et al. (1995). Rice gluten meal can be considered a good source of phosphorus (0.4%) that is of higher availability due to the enzymatic digestion process which increases phosphorus solubilisation. In comparison to corn gluten meal, the percentage of total amino acid relative to crude protein in rice gluten meal was found to be higher for most of the essential amino acids (lysine, methionine, arginine, valine, histidine), and nearly similar for isoleucine and threonine. On the other hand, it was decreased in case of phenylalanine and leucine. Rice gluten meal was 152, 85 and 58% higher in the arginine, methionine, and lysine levels when compared to corn gluten meal (See Table 1c).

Table 1a: Chemical composition of rice gluten meal

Item	Value (As is basis)
Moisture (%)	7.6
Dry matter (DM, %)	92.4
Crude protein (CP, %)	57.6
Ether extract (EE, %)	3.16
Crude fiber (CF, %)	1.45
Nitrogen free extract (NFE, %)	28.95
Ash	1.24
Minerals	
Calcium (%)	0.23
Phosphorus (%)	0.40
MEn (Kcal/kg)*	3330

Nitrogen corrected metabolizable energy; calculated according to the following equation: MEn (Kcal/kg dry matter) = 40.94 × CP + 88.17 × EE + 33.13 × NFE (Janssen, 1989).

Table 1b: Amino acid composition of rice gluten meal

Amino Acids	% (As is basis)
Lysine	1.57
Arginine	4.40
Methionine	2.65
Cystine	1.23
Threonine	1.95
Leucine	4.29
Isoleucine	2.36
Valine	3.24
Phenylalanine	3.13
Tyrosine	2.95
Histidine	1.34
Glycine	2.37
Alanine	3.17
Glutamic acid	9.60
Aspartic acid	4.72
Serine	2.70
Proline	2.46

There was a paucity of information about the proximate and amino acid composition of rice gluten meal. The nutritive value of rice gluten meal is comparable or even higher than that of corn gluten meal, particularly in the amino acid composition. While most producers think strictly on corn, soybean meal and corn gluten when feeding broilers, they need to realize that broilers require amino acids, energy, vitamins and minerals, rather than any particular feedstuff for normal growth (NRC, 1994). Therefore, rice gluten meal can be considered a potential alternative to balance the amino acid profile of the broiler diet with least cost.

Effect of feeding graded levels of rice gluten meal on the growth performance of broiler chicks

Productivity of broilers can be evaluated by determining BW gain, feed intake (FI), feed efficiency, and dressing percentage, etc. These parameters are mostly influenced by the diet physical and chemical compositions, therefore, when a new ration is being evaluated, great emphasis must be placed on these end points. Table 5 shows the body weight (BW), body weight gain (BW gain), feed intake (FI) and feed conversion ratio (FCR) of broilers fed graded level of rice gluten meal during starter, grower, finisher and overall periods. Inclusion of rice gluten meal did not significantly affect BW, BWG, FI and FCR at any rearing stage as well as cumulative period. Indeed, some isolated spots with statistically significant differences were detected for FCR at the inclusion rate of 5.0 %, but without quantitative relevance. The growth indices and feed conversion responses were not affected by feeding rice gluten meal even at the highest inclusion level (12.5% of the diet). These results agreed with Sherazi et al. (1995) who conducted an experiment to study the effect of replacing fish meal in broiler diet with rice gluten meal without balancing the amino acid profile. They found that rice gluten meal can be included in the broiler diets at levels up to 10% without negative effect on the feed conversion ratio. Waldroup (2000) reported that corn gluten meal can be included in broiler diets at a rate of 10% without impairing growth performance. Moreover, Seyedi and Hosseinkhani (2014) showed that corn gluten meal incorporation in broiler diets at low amounts (up to 6%) has no effect on the growth performance. On the other hand, Rose et al. (2003) reported a significant increase in feed intake when broiler chicks were fed a diet containing 10% corn gluten meal. The increase in feed intake of corn gluten meal contains diets in different studies could be attributed to the imbalance in the amino acids profile. The imbalanced amino acids profile in the feed can in part transmit some signals to the appetite center in the brain, which triggers lowering feed consumption (Harper, 1964). From the other part, Ping et al. (1972) stated that amino acid imbalance in the diet can reduce the consumption of lysine (corn gluten is deficient in Lysine) as the second limiting amino acid in broiler which in turn, making some signals in brain, that induces a reduction in the feed intake with poor growth performance. In the current study, balancing the amino acid profile was considered during formulation of different diets. As presented above, the amino acid composition of rice gluten meal is comparable or higher than that of corn gluten meal especially in some of the essential amino acids (methionine, lysine, arginine, valine and isoleucine). This is why further increase in rice gluten meal in broiler chicks diets with balancing of amino acid profile did not show any negative effects on broiler growth performance parameters.

Effect of feeding graded levels of rice gluten meal some serum parameters

Blood parameters have been observed to be important factors in assessing the response of animals to the diets they are fed (Khan and Zafar, 2005). The serum lipid profile of broiler chickens at 42 days of age

Table 1c: Comparison between the essential amino acid composition of corn gluten meal and rice gluten meal

Ingredient	Corn gluten meal		Rice gluten meal		
Total Amino acids (TAA), %	TAA*	% of TAA relative to CP	TAA**	% of TAA relative to CP	Difference (%)***
Crude protein	60.0		57.6		
Lysine	1.03	1.72	1.57	2.73	58.8
Methionine	1.49	2.48	2.65	4.60	85.3
Threonine	2.00	3.33	1.95	3.39	1.60
Arginine	1.82	3.03	4.40	7.64	151.8
Isoleucine	2.45	4.08	2.36	4.10	0.30
Valine	2.78	4.63	3.24	5.63	21.4
Histidine	1.2	2.00	1.34	2.33	16.3
Phenylalanine	3.56	5.93	3.13	5.43	-8.4
Leucine	10.04	16.73	4.29	7.45	-55.5

*Data obtained from NRC (1994); ** Own analysed data; ***Level of increase or decrease in the % of TAA relative to CP of rice gluten meal compared to corn gluten meal.

Table 2: Composition of the experimental diet of broiler chickens during starter period

	Rice gluten meal%					
Ingredient	0	2.5	5	7.5	10	12.5
Corn	57.8	56.9	55.7	58.6	58.3	58.9
SBM 44%	32.0	32.5	33.5	27.5	26.9	24.3
Corn gluten meal 60%	5.0	2.5	0	0	0	0
Rice gluten meal	0	2.5	5.0	7.5	10	12.5
Soybean oil	1.60	1.90	2.25	0.96	0.95	0.40
Dicalcium phosphate	1.60	1.60	1.60	1.60	1.60	1.60
Caco3	1.30	1.30	1.30	1.30	1.30	1.30
Vitamin and mineral premix*	0.30	0.30	0.30	0.30	0.30	0.30
Salts	0.35	0.35	0.35	0.35	0.35	0.35
Sodium bicarbonate	0.15	0.15	0.15	0.15	0.15	0.15
Choline	0.075	0.075	0.075	0.075	0.075	0.075
Lysine	0.34	0.32	0.29	0.45	0.46	0.53
Methionine	0.27	0.29	0.30	0.28	0.28	0.26
Threonine	0.03	0.03	0.025	0.04	0.04	0.04
Calculated nutrient composition**						
Crude protein%	22.1	22.0	22.0	22.0	22.0	22.2
ME kcal/kg diet	3000	3000	3000	3000	3000	3000
Crude fiber %	3.76	3.86	4.00	3.76	3.81	3.75
Ether extract %	4.40	4.79	5.20	4.22	4.35	3.99
Ca %	0.90	0.90	0.90	0.90	0.90	0.90
Available P%	0.45	0.45	0.45	0.45	0.45	0.45

Premix* per kg of diet: vitamin A, 1 500 IU; vitamin D3, 200 IU; vitamin E, 10 mg; vitamin K3, 0.5 mg; thiamine, 1.8 mg; riboflavin, 3.6 mg; D pantothenic acid, 10 mg; folic acid, 0.55 mg; pyridoxine, 3.5 mg; niacin, 35 mg; cobalamin, 0.01 mg; biotin, 0.15 mg; Fe, 80 mg; Cu, 8 mg; Mn, 60 mg; Zn, 40 mg; I, 0.35 mg; Se, 0.15 mg; ** Calculated according to NRC (1994).

after feeding graded levels of rice gluten meal was presented in Table 6. Serum total lipid, triglyceride, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL) did not differ significantly among dietary treatments. Earlier studies described in details the origin of plasma triglycerides, and the mechanism of fatty acid synthesis and deposition in the carcass. Excess plasma triglycerides (of either dietary or hepatic origin) can leads to fat accumulation in the body (Griffin et al., 1992). Plasma triglycerides are characterized as VLDL or LDL (Griffin et al., 1982), and the later is more available for fatty acid synthesis (Griffin and Whitehead, 1982). In broilers, the levels of VLDL and LDL are correlated to fat deposition in the carcass. Whitehead and Griffin (1984) indicated that plasma VLDL is a useful parameter to infer the degree of fatness in chickens. Increasing serum VLDL concentration (usually occur via stimulation of triglyceride-rich lipoprotein secretion from the liver and depressing fat uptake from blood circulation (Ho et al., 1989), resulting in a high level of serum lipid concentration and low abdominal fat accumulation.

The serum glucose, total protein, albumen and globulin of broiler chicks fed graded levels of rice gluten meal are presented in Table 7. There were no significant differences between treatments in these parameters. Moreover, the values of serum glucose, total protein, albumin and globulin are in normal range and compatible with the results of Obikaonu et al.

Table 3: Composition of the experimental diet of broiler chickens during grower period

	Rice gluten meal (%)					
Ingredients	0	2.5	5.0	7.5	10.0	12.5
Corn	61.2	60.2	58.9	60.2	61.5	62.4
SBM 44%	26.8	27.5	28.5	25.2	22.0	19.1
Corn gluten meal 60%	5.0	2.5	0	0	0	0
Rice gluten meal	0	2.5	5.0	7.5	10.0	12.5
Soybean oil	2.80	3.11	3.46	2.81	2.15	1.57
Dicalcium phosphate	1.64	1.64	1.64	1.65	1.67	1.7
Caco3	1.16	1.16	1.16	1.16	1.17	1.18
Vitamin and mineral premix*	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Sodium bicarbonate	0.15	0.15	0.15	0.15	0.15	0.15
Choline	0.075	0.075	0.075	0.075	0.075	0.075
Lysine	0.34	0.31	0.28	0.37	0.45	0.53
Methionine	0.24	0.26	0.27	0.26	0.25	0.23
Threonine	0.03	0.03	0.025	0.033	0.04	0.043
Calculated nutrient composition**						
Crude protein %	20.0	20.0	20.0	20.0	20.0	20.0
ME kcal/kg diet	3100	3100	3100	3100	3100	3100
Crude fiber %	3.45	3.56	3.68	3.60	3.51	3.45
Ether extract %	5.73	6.04	6.50	6.00	5.60	5.21
Ca %	0.90	0.90	0.90	0.90	0.90	0.90
Available P%	0.45	0.45	0.45	0.45	0.45	0.45

Premix* per kg of diet: vitamin A, 1 500 IU; vitamin D3, 200 IU; vitamin E, 10 mg; vitamin K3, 0.5 mg; thiamine, 1.8 mg; riboflavin, 3.6 mg; D pantothenic acid, 10 mg; folic acid, 0.55 mg; pyridoxine, 3.5 mg; niacin, 35 mg; cobalamin, 0.01 mg; biotin, 0.15 mg; Fe, 80 mg; Cu, 8 mg; Mn, 60 mg; Zn, 40 mg; I, 0.35 mg; Se, 0.15 mg; ** Calculated according to NRC (1994).

Table 4: Composition of the experimental diet of broiler chickens during finisher period

	Rice gluten meal (%)					
Ingredient	0	2.5	5.0	7.5	10.0	12.5
Corn	61.5	60.9	59.6	61.0	62.2	62.8
SBM 44%	25.4	25.5	26.6	23.2	20.0	17.3
Corn gluten meal 60%	5.0	2.5	0	0	0	0
Rice gluten meal	0	2.5	5.0	7.5	10.0	12.5
Soybean oil	4.40	4.56	4.90	4.25	3.60	3.05
Dicalcium phosphate	1.64	1.66	1.67	1.68	1.70	1.71
Caco3	1.15	1.15	1.16	1.16	1.17	1.18
Vitamin and mineral premix*	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Sodium bicarbonate	0.15	0.15	0.15	0.15	0.15	0.15
Choline	0.075	0.075	0.075	0.075	0.075	0.075
Lysine	0.20	0.20	0.16	0.25	0.33	0.40
Methionine	0.17	0.19	0.20	0.19	0.18	0.16
Threonine	0.03	0.03	0.025	0.04	0.04	0.04
Calculated nutrient composition**						
Crude protein%	19.0	19.0	19.0	19.0	19.0	19.0
ME kcal/kg diet	3200	3200	3200	3200	3200	3200
Crude fiber %	3.51	3.54	3.5	3.46	3.44	3.41
Ether extract %	7.89	8	7.72	7.45	7.2	6.96
Ca %	0.90	0.90	0.90	0.90	0.90	0.90
Available P%	0.45	0.45	0.45	0.45	0.45	0.45

Premix* per kg of diet: vitamin A, 1 500 IU; vitamin D3, 200 IU; vitamin E, 10 mg; vitamin K3, 0.5 mg; thiamine, 1.8 mg; riboflavin, 3.6 mg; D pantothenic acid, 10 mg; folic acid, 0.55 mg; pyridoxine, 3.5 mg; niacin, 35 mg; cobalamin, 0.01 mg; biotin, 0.15 mg; Fe, 80 mg; Cu, 8 mg; Mn, 60 mg; Zn, 40 mg; I, 0.35 mg; Se, 0.15 mg; ** Calculated according to NRC (1994).

(2012). Serum biochemical parameters are indicators for the physiological, pathological, and nutritional status of the animal, and have the potential of being used to elucidate the impact of nutritional factors and additives supplied in the diet (Madubuike and Ekenyen, 2006). Also, it has been observed that levels of serum urea, total protein and creatinine depend on both the quality and quantity of dietary protein (Iyayi and Tewe, 1998). The serum biochemical parameters obtained from this study suggested that dietary rice gluten meal has no deleterious effects on the internal physiology of broiler chickens.

Table 5: Effect of feeding graded level of rice gluten meal on the growth performance of broiler chickens

Parameters	Rice gluten meal (%)					
	0	2.5	5.0	7.5	10.0	12.5
Starter phase						
Body weight (g)	447±13.5	452±11.5	448±16.0	454±12.9	451±13.4	453±18.2
Body gain (g)	371±13.2	375±11.4	373±16.9	377±12.4	375±12.8	376±17.8
Feed intake (g)	474±17.8	482±7.60	488±16.0	476±14.3	479±12.9	475±17.0
Feed conversion ratio	1.28^{b}±0.01	1.29^{ab}±0.02	1.31^{a}±0.02	1.26^{b}±0.01	1.28^{b}±0.01	1.26^{b}±0.02
Grower phase						
Body weight (g)	1412±19.2	1411±14.3	1400±12.2	1422±23.9	1416±24.8	1408±20.5
Body gain (g)	965±26.7	959±16.7	952±7.6	968±23.6	965±24.0	955±34.8
Feed intake (g)	1694±42.8	1686±35.6	1700±19.0	1695±63.0	1695±37.7	1677±47.6
Feed conversion ratio	1.76±0.02	1.76±0.03	1.79±0.02	1.75±0.03	1.76±0.02	1.76±0.02
Finisher phase						
Body weight (g)	2404±53.2	2416±36.5	2400±29.2	2422±44.4	2430±35.4	2424±40.4
Body gain (g)	992±41.5	1005±36.7	1000±17.3	1000±33.2	1014±22.2	1016±46.7
Feed intake (g)	1851±72.5	1896±53.2	1916±39.7	1882±60.6	1914±39.7	1922±90.4
Feed conversion	1.87^{a}±0.02	1.88^{a}±0.02	1.92^{a}±0.02	1.88^{a}±0.02	1.88^{a}±0.03	1.89^{ab}±0.02
Cumulative (1- 42 days of age)						
Body gain (g)	2328±51.1	2339±36.8	2325±30.1	2345±43.5	2354±35.9	2347±40.5
Feed intake (g)	4019±102	4064±82.0	4104±44.9	4053±68.3	4088±54.3	4074±80.7
Feed conversion ratio	1.73^{b}±0.01	1.74^{b}±0.01	1.77^{a}±001	1.73^{b}±0.01	1.74^{b}±0.02	1.74^{b}±0.01

^{a,b} means within the same row with different superscripts are significantly different at $p<0.05$

Table 6: Effect of feeding graded level of rice gluten meal on the serum lipid profile (mg/dl) ± SEM of broiler chickens

Parameters	Rice gluten meal (%)					
	0	2.5	5.0	7.5	10.0	12.5
Total lipids	265±15.7	258±5.4	260±12.5	255±11.6	262±13.6	265±10.1
Triglycerides	196±13.4	203±15.5	195±7.9	202±11.2	196±12.1	198±14.3
Total cholesterol	138±8.26	145±9.17	137±7.47	148±6.54	142±5.26	139±5.83
HDL	69.2±3.96	70.0±5.83	68.6±5.46	71.8±4.55	70.2±4.21	71.0±
LDL	54.4±4.83	53.0±2.77	54.0±3.00	53.6±4.83	53.2±4.09	53.6±5.03
VLDL	11.2±0.84	11.6±0.58	11.6±0.54	11.8±0.78	11.5±0.79	11.7±0.67

Table 7: Effect of feeding graded level of rice gluten meal on the serum glucose (mg/100 ml), total protein, albumin and globulin (g/dl) ± SEM of broiler chickens

Parameters	Rice gluten meal (%)					
	0	2.5	5.0	7.5	10.0	12.5
Glucose	199±6.66	202±7.04	198±8.15	195±4.56	203±9.63	196±6.54
Total protein	3.35±0.08	3.41±0.09	3.32±0.09	3.42±0.11	3.39±0.11	3.45±0.13
Albumin	2.30±0.17	2.29±0.10	2.26±0.13	2.28±0.10	2.26±0.06	2.29±0.08
Globulin	1.16±0.03	1.15±0.03	1.18±0.02	1.16±0.02	1.17±0.03	1.16±0.03

Table 8: Effect of feeding graded level of rice gluten meal on the apparent total tract nutrients digestibility of broiler chickens

Parameters	Rice gluten meal (%)					
	0	2.5	5.0	7.5	10.0	12.5
Dry matter %	71.0±1.58	70.7±0.55	70.8±1.30	71.0±1.27	70.3±0.75	71.3±1.58
Crude protein %	63.4±1.24	63.5±1.84	63.4±1.46	63.7±1.54	63.6±2.06	63.8±1.34
Starch %	86.5±0.88	86.3±1.51	85.6±0.48	86.1±1.79	86.8±1.23	86.4±1.20
Ether extract %	86.3±1.01	86.6±1.28	85.9±1.56	85.3±1.95	86.7±1.50	86.1±1.62
NDF %	11.6±0.73	11.8±0.41	11.6±0.41	11.7±0.29	11.7±0.49	11.6±0.45

Table 9: Effect of feeding graded level of rice gluten meal on the carcass traits (dressing% and organs weight expressed as a percentage of body weight) ± SEM of 42-d-old broiler chickens

Parameters	Rice gluten meal (%)					
	0	2.5	5.0	7.5	10.0	12.5
Carcass dressing	69.8±1.11	69.3±0.88	69.9±0.92	69.5±0.77	69.8±1.29	69.3±0.84
Liver	3.05±0.13	3.01±0.08	3.02±0.08	3.05±0.10	3.02±0.12	3.01±0.11
Heart	0.62±0.04	0.60±0.04	0.61±0.02	0.59±0.05	0.61±0.02	0.59±0.04
Spleen	0.53±0.02	0.52±0.03	0.53±0.04	0.52±0.05	0.51±0.04	0.52±0.04
Gizzard	2.85±0.06	2.82±0.10	2.89±0.04	2.82±0.07	2.89±0.04	2.87±0.09

Effect of feeding graded levels of rice gluten meal on apparent nutrient digestibility of broiler chickens

Apparent nutrient digestibility (%) in broiler chickens fed graded levels of rice gluten meal are illustrated in Table 8. Results indicated that apparent digestibility of dry matter, crude protein, starch, ether extract and NDF of broilers fed different levels of rice gluten meal did not differ among treatments. Overall means of the apparent digestibility of dry matter, crude protein, starch, ether extract and NDF was in the normal range (71, 63, 86, 86, and 11.6%, respectively). Results indicated that high level of rice gluten meal didn't affect nutrients digestibility. Digestibility of rice gluten meal was rarely described before, therefore the it was difficult to find other publication to discuss it with the current study.

Effect of feeding graded levels of rice gluten meal on some carcass characteristics of broiler chickens

The carcass dressing and internal organs weights as a percentage of the carcass weight are reported in Table 9. There was no significant difference among treatments, and that consumption of the rice gluten meal had no effect on relative organ weights and carcass dressing. This is in agreement with Sherazi et al. (1995) who found that adding rice gluten meal up to 10% did not influence the dressing percentage. To date, no studies have been found in the literature on the effects of feeding rice gluten meal on non-commercial carcass components. Regarding to corn gluten meal, Ismail et al. (2005) reported that adding corn gluten meal to broiler diets have an adverse effect on carcass traits. This could be attributed to the amino acids imbalance, reduction of lysine consumption, reduction of protein consumption and/or imbalanced ratio of energy to amino acids. On the other hand, Seyedi and Hosseinkhani (2014) stated that higher amount of corn gluten meal in the broiler diets (i.e. 12%) can improve breast weight and numerically reduce abdominal fat of the birds. Additionally, Rose et al. (2003) reported an increase in the carcass fat and dressing percentage due to inclusion of various level of corn gluten meal in broiler diets

Conclusion

Inclusion of rice gluten meal in broiler diets did not show any negative effect on the growth performance, carcass traits, nutrients digestibility as well as serum glucose or lipid profile. Therefore, it can be used as a partial alternative protein source for soybean meal and corn gluten meal in poultry diets.

Acknowledgement

The authors gratefully acknowledge and appreciate Tiba Starch and glucose manufacturing co., New salheya, Egypt, for the financial support of this study.

References

Agwunobi LN (1999) Performance of broiler chicks fed sweet potato meal (Ipomoea batatas L.) diets. Trop Anim Health Prod 31: 383-389.

Alias I, Ariffin T (2008) Potential of feed rice as an energy source for poultry production. Pages 31–38 in Proceedings of Workshop on Animal Feedstuffs in Malaysia: Exploring Alternative Strategies, Putrajaya, Malaysia.

AOAC (2006) Official Methods of Analysis. 18th ed AOAC Int, Gaithersburg, MD.

Asyifah MN, Abd-Aziz S, Phang LY, Azlian MN (2012) Brown rice as a potential feedstuff for poultry. J Appl Poult Res 21: 103–110.

Aho P (2007) Impact on the world poultry Industry of the global shift to biofuels. Poult Sci 86: 2291–2294.

Ayuk EA (2004) Effect of sweet potato meal on the growth rate of broilers. Livest Res Rural Dev 16 Article # 73.

European Commission 1998 ANNEX. Part A Determination of Amino Acids. Off J Eur Commun. L257: 16–23.

Donohue M, Cunningham DL (2009) Effects of grain and oilseed prices on the costs of US Poultry production. J Appl Poult Res 18: 325–337.

Griffin HD, Whitehead CC (1982) Plasma lipoprotein concentration as an indicator of fatness in broiler: development and use of a simple assay for plasma very low density lipoprotein. Br Poult Sci 23: 307-313.

Griffin HD, Grant G, Perry M (1982) Hydrolysis of plasma triacylglycerol-rich lipoproteins from immature and laying hens (Gallus domestricus) by lipoprotein lipase in vitro. Biochem J 206: 647-654.

Griffin HD, Guo K, Windsor D, Butterwith SC (1992) Adipose tissue lipogenesis and fat deposition in leaner broiler chicken. J Nutr 122: 363-368.

Harper, AE (1964) Amino acid imbalance. Vol II in Mammalian protein metabolism. (H N Munro, J B Allison) Academic press. New York, NY. Pp: 87–134.

Ho HT, Kim DN, Lee KT (1989) Intestinal apolipoprotein B-48 synthesis and lymphatic cholesterol transport are lower in swine fed high fat, high cholesterol diet with soy protein than with casein. Atherosclerosis 77: 15.

Honda K, Kamisoyama H, Ikegami K, Hasegawa S (2011) Amino acid digestibility of rice at different sites of chicken intestines. J Poult Sci 48: 85-91.

Iyayi EA and Tewe, OO 1998 Serum total protein, urea and creatinine levels as indices of quality cassava diets for pigs. Trop Vet 16: 57-67.

Ismail, M, Memon, A, Solagi, AA, Ansari, NN, Rind, MI (2005) Effect of different levels of maize gluten meal on the growth performance of broiler chicks. J Anim Vet Adv 4: 377-380.

Janssen WMMA (1989) European Table of Energy Values for Poultry Feedstuffs. 3rd ed Beekbergen, Netherlands: Spelderholt Center for Poultry Research and Information Services.

Khan TA, Zafar F (2005) Haematological study in response to varying doses of estrogen in broiler chicken. Inter J Poult Sci 10: 748-751.

Kreutzer DW (2012) Renewable fuel standard, ethanol use, and corn prices. Background, Heritage Foundation No 2727.

Madubuike FN, Ekenyen BU (2006) Haematology and serum biochemistry characteristics of broiler chicks fed varying dietary levels of Ipomoea asarifolia leaf meal. Int J Poult Sci 5: 9-12.

Mourao JL, VM Pinheiro, JAM Prates, RJB Bessa, LMA Ferreira CMGA, Fontes, Ponte PIP (2008) Effect of dietary dehydrated pasture and citrus pulp on the performance and meat quality of broiler chickens. Poult Sci 87: 733-743.

National Research Council (1994) Nutrient Requirements for Poultry. 9th rev ed Natl Acad Press, Washington, DC.

Obikaonu HO, Okoli IC, Opara MN, Okoro VMO, Ogbuewu IP, Etuk EB, Udedibie ABI (2014) Haematological and serum biochemical indices of starter broilers fed leaf meal of neem (Azadirachta indica). J Agr Technol 8: 71-79.

Ojewola GS, Olojede AO, Ehiri CG (2006) Evaluation of Livingston potato/Rizga (Plectranthus esculentus NBr) and Hausa potato (Solenostemon rotundifolius Poir) as energy sources for broiler chicken. J Anim Vet Adv 5: 472–477.

Ping Y, Tews JK, Harper AE (1972) Amino acid imbalance. Protein intake and changes in rat brain and plasma amino acids. Amer J of phys 222: 314-321.

Rose SP, Pirgozliev VR, Countney J, Hare SD (2003) dietary protein source and lysine balance on the efficiency of energy utilization in broiler chickens. International symposioum, rostock warnemunde, germany. Pp: 227-230.

Sherazi TH, AIam MZ, GiIani AH, Nawaz H (1995) Graded replacement of fish meal with rice protein meal in broiler ration. Pak J Agri Sci 32: 2-3.

Seyedi AH, Hosseinkhani A (2014) Evaluation Corn Gluten Meal Nutritive Value for Broiler Chicks. Int J Adv Biol Biom Res 2 (9): 2609-2615.

Schneider BH, Flatt WP (1975) The Evaluation of Feeds Through Digestibility Experiments. Athens, Georgia: University of Georgia Press. p: 423.

Short FJ, Wiseman J, Boorman KN (1999) Application of a method to determine ileal digestibility in broilers of amino acids in wheat. Anim Feed Sci Technol 79: 195–209.

Sittiya J, Yamauchi K, Morokuma M (2011) Chemical composition, digestibility of crude fiber and gross energy, and metabolizable energy of whole paddy rice of Momiroman. J Poult Sci 48: 259-261.

Waldroup PW (2000) Present status of the use of digestible amino acid values in formation of broiler diets: opportunities and obstacles. Asi- Aust J Anim Sci 8: 76-87.

Whitehead CC, Griffin HD (1984) Development of divergent lines of lean and fat broilers using plasma low density lipoprotein concentration as a selection criterion: the first three generations. Br Poult Sci 25: 573-582.